QUANTITATIVE ANALYSIS ON THE CONTRIBUTION RATES OF SOURCES OF CONSTRUCTION WASTE

B.Amirthakadeshwaran[1*], V.G.Kalpana[2]

[1*]PG Student, ME Construction Management, Coimbatore Institute of Technology, Coimbatore, India.

[2]Assistant Professor, Department of Civil Engineering, Coimbatore Institute of Technology, Coimbatore, India.

Article History: Received 3.3.2017; Revised 12.7.2017; Accepted 21.12.2017

ABSTRACT

The Construction industry is environmentally unfriendly. The construction waste has negative impacts on soil, water and surroundings of the environment. It also contributes additional cost to construction for waste replacement. In order to mitigate the construction waste it is important to explore waste management options that includes, reducing, reusing, recycling, refusing and disposing of waste. Therefore, for this purpose, it is necessary to identify the sources of construction waste and its causative factors. The most significant part of the project is to study the contribution rates of different identified sources of construction waste and its causative factors. The contribution rates of different sources and its causative factors will help in developing the ways to minimize the waste. Questionnaire survey is done to assess the frequency and severity of contribution rate of construction waste. Quantitative analysis is adopted to find the contribution rates. Prior to finding contribution rates it is necessary from the sources of waste and its factors to undergo various tests. The findings from this test will enhance in checking the reliability of the data.

KEYWORDS: *Sources of waste; causative factors; frequency; severity; ordinal logistic regression; goodness of fit; correlation matrix; contribution rates.*

1.0 INTRODUCTION

Construction waste consists of a wide variety of materials which are in the form of concrete, steel, bricks, tiles and other materials arising from various construction activities. The survey conducted across the world found that India contributes about 4% of construction waste after China (48%), Japan (21%), Hong Kong and South Korea (7%). As per Technological Information Forecasting and Assessment Council (TIFAC), India is estimated to contribute 11.4 to 14.69 million tonnes per annum. Though the construction industry has the major economic contribution, the construction waste generated creates more impact on the environment, economic and social life. Hence, construction waste management plays a vital role to enhance reduction, reuse, and recycling of waste before disposal. The reduction in wastage level of materials in the construction industry has the potential to minimize the cost of construction.

* Corresponding Email: amirthakadeshwaran93@gmail.com

Construction of commercial buildings and housing development projects are the main sources for the generation of the huge amount of construction waste. The other sources of construction waste are design, procurement, material handling, operations, residuals and others (R.M Gavilan & L.E.Bernold 1994). Lack in updating information about on site stocks, supply and location of materials on site and reordering the same material are other causes of waste generation (Navon & Berkovich 2006). Further, waste can also arise due to external factors such as theft and vandalism (B. A. G. Bossink & H. J. H. Brouwers 1996). The aim of this study is to identify the sources of waste and its causative factors and hence the estimation of contribution rates of sources of waste by quantitative analysis. The quantitative analysis helps in the estimation of the cost of waste and to develop mitigation strategy for minimising waste.

2.0 LITERATURE STUDIES

The various research studies have been carried out to analyse waste arising from construction activities. The study (Burcu Salgın.,Atacan Akgün., Nilay Coşgun.&, Kofi Agyekum, 2017) examined the potential of BIM applications in preventing/reducing waste in the construction process by identifying the reasons of waste generation in the construction sector. The study (T.O.Adeuvi & I.A.Odesola, 2015) found the various sources contributing to construction waste available on the sites in Nigeria. It is concluded that the stakeholders in the construction industry should jointly consider waste minimisation strategies to reduce the level of waste generated on site. The study (O.O. Fadiya, P.Georgakis, and E. Chinyio, 2014) revealed contribution rates of nine identified sources of construction waste. By questionnaire survey the frequency and severity of the contribution of the sources of waste were assessed and found that residual waste such as material off-cuts was the highest contributor to construction waste. The output (Sasitharan Nagapan, Ismail Abdul Rahman & Adi Usmi, 2014) revealed various causative factors contributing construction waste generation. By conducting interviews and adopting Mapping technique the physical and non-physical waste were detected and from the triangulation method, it was concluded that 63 factors contribute to physical waste and 73 contribute to non-physical waste.

The findings (Job Thomas & Wilson P.M, 2013) regarding various sources of waste and contributors of construction and demolition waste were identified and discussed the importance of 3R.The findings (Nikola Karanovic & Aleksander Djuric, 2012) introduced a method of calculating the quantity of construction waste from construction materials used for single family house and multifamily house on site in city of Novi Sad. The objective (Mansi Jain, 2012) focussed on finding constitutes of construction waste, sources of waste generation, economic feasibility in handling waste at the construction site for cost saving by cost benefit analysis and mitigation strategy for the problem. The study (Babatunde & Solmon Olusola, 2012) quantitatively assessed the percentage of construction material wastage in Nigerian construction sites and reported that theft and vandalism waste ranked highest with 16.58% followed by cutting waste by 15.44%. The majority found (Carlos T Formoso, Lucio Soibdman, Claudio De Lesare & Edurado L Isatto, 2002) the sources of wastes and measuring the waste materials in building projects at Brazil and proposed some strategies to improve the managerial capacity of companies at the design, procurement, and production stages.

The study helped in (A. Gliem, Rosemary & R. Gliem, 2002) calculating Cronbach's Alpha to check the reliability of the data.

3.0 RESEARCH METHODOLOGY

The methodology adopted for research is quantitative research method. Information about the world is acquired through this method. It is typically sampled survey and experiment. The quantitative research method is used to describe variables, examine relationships among variables and explore the strength of each variable. The research methodology is divided into two segments.

1. Data collection through questionnaire survey
2. Quantitative Analysis

Questionnaire survey consists of two sections. The first section had the details of the respondent and organization details. The second section had the frequency and severity of contribution rates of waste sources and its causative factors. Data collection is done based on the various sources of construction waste and its causative factors. For the corresponding source, various causative factors were determined. The sources of waste were classified into eleven groups such as procurement, design, workers' mistakes, management plan, material handling, site condition, logistics, manufacturing, operations, misplacement and external sources. Based on the source and causative factors, manual survey and online survey were done. The questionnaire survey was in the form of a 5 point Likert scale determining the contribution rates of each causal factor. The contribution rates were segregated into frequency contribution rates and severity contribution rates. The 5 point Likert scale mentioned 1 to be no contribution, 2 as little contribution, 3 as moderate contribution, 4 as high contribution and 5 as extreme contribution.

The second phase of the methodology is the analysis phase. The analysis has been done using Minitab17. This phase is classified into five stages. In the initial stage the response from the respondents are entered into Minitab17 software. The first analysis involves finding ordinal logistic regression. The second stage of analysis involves finding goodness of fit, which is based on Pearson and deviance value. The third stage of analysis is finding correlation matrix. The fourth stage of analysis is finding Cronbach value for testing its reliability. The fifth stage of analysis is finding the contribution rates using the formulae. The contribution rates are found only if the data are reliable.

4.0 DATA ANALYSIS

The collected data is entered in Minitab17. Each source is compared with another source to find the p-value from the ordinal logistic regression. Figure-1 depicts the output from Minitab17 of ordinal logistic regression values for procurement and operations. The p -value can be found for other combinations such as procurement with design, procurement with worker mistakes, procurement with material handling, procurement with the management plan, procurement with logistics, procurement with site conditions, procurement with misplacement, procurement with external sources. Similarly, all the combinations can be found out. Table-1 shows the p-value for frequency for all the combinations. From the table it is clear that the p-value is less than 0.05 for 95% significance level and hence the value becomes significant.

```
Logistic Regression Table

                                                        Odds     95% CI
Predictor        Coef     SE Coef      Z       P    Ratio  Lower  Upper
Const(1)    -0.649576   0.848101  -0.77   0.444
Const(2)      2.00186   0.805117   2.49   0.013
Const(3)      4.12071   0.909752   4.53   0.000
Operations  -0.902423   0.312664  -2.89   0.004    0.41   0.22   0.75


Log-Likelihood = -93.438
Test that all slopes are zero: G = 7.518, DF = 1, P-Value = 0.006
```

Figure 1. Ordinal Logistic Regression for Frequency (Procurement vs Operations)

Table 1. Ordinal Logistic Regression for Frequency (p-value for 95% significance level)

Freq	**Proc**	**Design**	**Workers Mistake**	**Mangt Plan**	**Material Handling**	**Site Cond**	**Logistics**	**Manf**	**Operation**	**Mis placement**
Design	0.000									
Workers Mistake	0.000	0.000								
Mangt Plan	0.001	0.000	0.000							
Material Handling	0.000	0.000	0.000	0.000						
Site Condition	0.000	0.000	0.000	0.000	0.000					
Logistics	0.000	0.000	0.000	0.000	0.000	0.000				
Manf	0.001	0.000	0.000	0.000	0.000	0.000	0.000			
Operation	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
Mis Placement	0.001	0.004	0.002	0.002	0.002	0.001	0.000	0.000	0.000	
External Sources	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure-2 depicts the Minitab values for goodness of fit for procurement and operations. Table-2 and Table-3 shows the value for goodness of fit, which is based on Pearson, and Deviance value for frequency respectively. The value should lie in the range from 0 to 1. The higher the value the better the model fits the data. The combinations of manufacturing and management plan proved to be the best fit for the model.

```
Goodness-of-Fit Tests

Method    Chi-Square  DF      P
Pearson      181.085  11  0.000
Deviance      17.647  11  0.090
```

Figure 2. Goodness of Fit for Frequency (Procurement vs Operation)

Table 2. Goodness-of-Fit Tests based on Pearson value for Frequency

Freq	**Proc**	**Design**	**Workers Mistake**	**Mangt Plan**	**Material Handling**	**Site Cond**	**Logistics**	**Manf**	**Operation**	**Mis placement**
Design	0.321									
Workers Mistake	0.402	0.992								
Mangt Plan	0.000	0.149	0.994							
Material Handling	0.000	0.992	0.410	0.713						
Site Condition	0.000	0.954	0.141	0.845	0.779					
Logistics	0.000	0.977	0.371	0.441	0.553	0.758				
Manf	0.000	0.002	0.603	0.999	0.616	0.083	0.525			
Operation	0.000	0.952	0.377	0.821	0.937	0.270	0.251	0.957		
Mis Placement	0.000	0.833	0.153	0593	0.095	0.366	0.755	0.808	0.506	
External Sources	0.000	0.427	0.577	0.990	0.530	0.546	0.469	0.984	0.940	0.943

Table 3. Goodness-of-Fit Tests based on Dearson value for Frequency

Freq	**Proc**	**Design**	**Workers Mistake**	**Mangt Plan**	**Material Handling**	**Site Cond**	**Logistics**	**Manf**	**Operation**	**Mis placement**
Design	0.415									
Workers Mistake	0.264	0.976								
Mangt Plan	0.009	0.584	0.988							
Material Handling	0.060	0.940	0.667	0.685						
Site Condition	0.107	0.875	0.534	0.893	0.749					
Logistics	0.060	0.915	0.482	0.352	0.378	0.716				
Manf	0.186	0.429	0.527	0.994	0.484	0.140	0.364			
Operation	0.090	0.893	0.627	0.709	0.889	0.142	0.099	0.944		
Mis Placement	0.209	0.748	0.119	0.531	0.317	0.262	0.759	0.668	0.444	
External Sources	0.018	0.339	0.633	0.926	0.551	0.373	0.374	0.987	0.939	0.929

Figure-3 represents the output from Minitab17 of correlation matrix values for procurement with other sources. Table-4 shows the correlation matrix value for all the combinations.

	Procurement
Design	0.666
Workers mistakes	0.520
Management Plan	0.571
Material Handlin	0.430
Site Condition	0.464
Logistics	0.527
Manufacturing	0.462
Operations	0.347
Misplacement	0.344
External Source	0.326

Figure 3. Correlation Matrix values for Frequency (Procurement vs All other Sources)

Table-4 - Correlation Matrix values for Frequency

Freq	**Proc**	**Design**	**Workers Mistake**	**Mangt Plan**	**Material Handling**	**Site Cond**	**Logistics**	**Manf**	**Operation**	**Mis placement**
Design	0.666									
Workers Mistake	0.520	0.644								
Mangt Plan	0.571	0.705	0.755							
Material Handling	0.430	0.655	0.644	0.696						
Site Condition	0.464	0.504	0.524	0.683	0.710					
Logistics	0.527	0.620	0.539	0.725	0.754	0.739				
Manf	0.462	0.623	0.570	0.719	0.671	0.635	0.790			
Operation	0.347	0.523	0.549	0.536	0.614	0.545	0.635	0.590		
Mis Placement	0.344	0.367	0.375	0.420	0.484	0.361	0.501	0.380	0.696	
External Sources	0.326	0.504	0.446	0.534	0.593	0.536	0.612	0.629	0.585	0.568

The correlation matrix value should lie in the range 0 to 1. If the values fall below it, the particular variable is omitted and analysis is continued.

Figure-4 shows the output values from Minitab17 of Cronbach value for all sources. Cronbach's alpha is most widely used objective measure of reliability of internal consistency of multi items. (M. Tavakol and R. Dennick 2011). Table-5 shows the Cronbach value, which determines the reliability of the data. This Cronbach value should lie between 0.7-1. The item adjusted total correlation and squared multiple should be relatively lower than the Cronbach value.

Cronbach's alpha = 0.9343

Omitted Item Statistics

Omitted Variable	Adj. Total Mean	Adj. Total StDev	Item-Adj. Total Corr	Squared Multiple Corr	Cronbach's Alpha
Procurement	27.496	5.973	0.5935	0.5476	0.9334
Design	27.284	5.804	0.7465	0.6881	0.9272
Workers mistakes	27.196	5.881	0.7160	0.6578	0.9285
Management Plan	27.123	5.658	0.8240	0.7679	0.9237
Material Handling	27.382	5.844	0.8088	0.7211	0.9249
Site Condition	27.391	5.865	0.7309	0.6620	0.9279
Logistics	27.396	5.768	0.8368	0.7821	0.9232
Manufacturing	27.276	5.751	0.7824	0.7167	0.9256
Operations	27.648	5.921	0.7186	0.6755	0.9286
Misplacement	27.770	5.939	0.5554	0.6006	0.9358
External Source	27.757	5.967	0.6801	0.5545	0.9302

Figure 4. Reliability Test based on Crobach's Value for Frequency

Table 5. Reliability Test for Frequency

Sources	**Cronbach's Alpha**
Procurement	0.9334
Design	0.9272
Workers Mistake	0.9285
Management Plan	0.9237
Material Handling	0.9249
Site Condition	0.9279
Logistics	0.9232
Manufacturing	0.9256
Operations	0.9286
Misplacement	0.9358
External Sources	0.9302

The contribution rates of the sources and its causative factors are computed using the equation mentioned below. Equation (1) helps in finding the frequency index value based on probability values and weightage of each category. Equation (2) helps in computing severity index value. Contribution Index values are calculated using the equation (3) which is based on frequency and severity index values. The ratio of the number of respondents who selected a particular category to the total number of respondents paved the way to find probability values for frequency from the equation (4). Equation (5) helps in calculating the ratio of number of respondents who selected a particular category in severity to the total number of respondents to find the probability values for severity. Contribution rates are found using equation (6). Based on the contribution rates for each source, appropriate mitigation strategy is applied to each source. To compute the percentage of waste that can be reduced, total number of mitigation strategies adopted and total number of causative factors are calculated. The ratio of these two will give the percentage of waste that can be computed. Equation (7) helps in finding the percentage of waste that can be reduced. Table-6 and Table-7 shows the contribution rates of the sources and its causative factors which are computed using the equations mentioned below. Figure-5 shows the contribution rates for the sources.

Formulae used:

$$F = \sum_{r=1}^{5} \left[A(r) \times w(r) \right] \tag{1}$$

$$S = \sum_{r=1}^{5} \left[B(r) \times w(r) \right] \tag{2}$$

$$C = F \times S \tag{3}$$

$$A(r)=\left(\frac{f(r)}{n}\right) \tag{4}$$

$$B(r)=\frac{s(r)}{} \tag{5}$$

$$CR=\left[\frac{C}{\sum C}\right]\times 100 \tag{6}$$

$$P=\left[\frac{n_2}{n_1}\right]\times 100 \tag{7}$$

where

F - Frequency Indices

r – rating category

$A(r)$ – Probability values for frequency

$w(r)$ – weightage of the category r

S – Severity Indices

$B(r)$ – Probability values for severity

C – Contribution Indices

$f(r)$ – number of respondents who selected r for frequency

$s(r)$ – number of respondents who selected r for severity

n – Total number of respondents

CR – Contribution Rates

P - Percentage of waste that can be reduced

n_2 - total number of mitigation strategies adopted

n_1 - total number of causative factors

Table 6. Contribution rates of the sources

Contribution rates of the sources	Percentage(%)
Procurement	9.062
Design	10.324
Worker's Mistakes	10.686
Management Plan	11.289
Material Handling	9.250
Site Condition	9.394
Logistics	8.719
Manufacturing	9.867
Operation	7.673
Misplacement	6.710
External Sources	7.026

Table 7. Contribution rates of the causative factors

Contribution rates of the causative factors	Percentage(%)
Management Plan [Poor Planning, Controlling and Supervision]	2.866
Management Plan [Lack of waste management plan]	2.583
Worker's Mistakes [Shortage of skilled labour]	2.545
Design [Frequent design changes]	2.541
Manufacturing [Deviation from standard sizes]	2.478
Worker's Mistakes [Poor attitudes of worker]	2.430
Management Plan [Lack of coordination among parties]	2.429
Worker's Mistakes [Inappropriate use of material]	2.397
Management Plan [Inappropriate construction method]	2.376

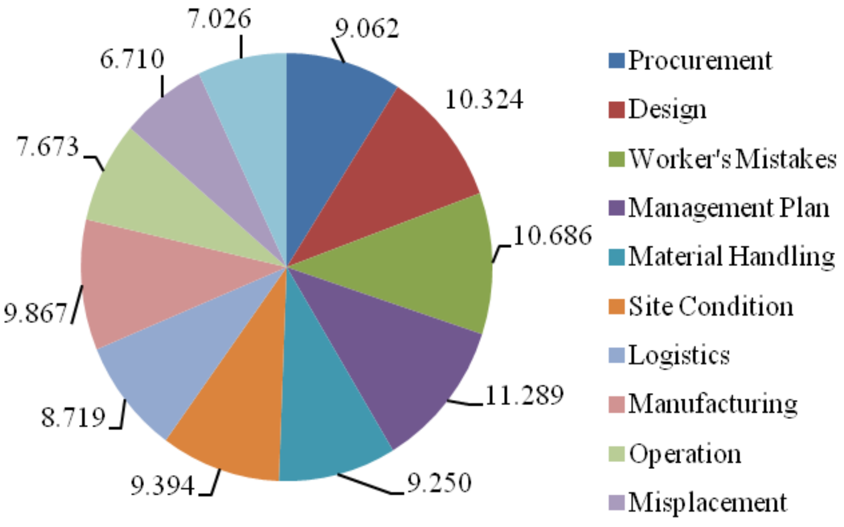

Figure 5. Contribution Rates for Sources

Table-8 shows the percentage of waste that can be reduced adopting the various mitigation strategies. It is observed that waste can be reduced by decreasing the contribution rates of each source and its causative factors. The contribution rate for each factor has been found. Mitigation measures are dependent on causes of waste generation. The average of contribution rates of causative factors that can be adopted to minimize waste is calculated. This value is converted to percentage by adopting standard methods. The P value obtained from equation (6) is multiplied by the obtained value to find the reduction in percentage of waste.

Table 8. Reduction in percentage of waste

Sources	**Percentage of waste that can be reduced**
Management Plan	6.66
Workers mistakes	5.64
Design	5.67
Manufacturing	5.85
Site Condition	5.41
Material Handling	5.30
Procurement	5.11
Logistics	4.72
Operation	4.43
External Sources	4.21

5.0 RESULTS AND DISCUSSION

The initial step of reducing the construction waste is to act upon the sources and its causative factors. The field work obtained from the various construction industries infers that most of the wastes generated are disposed. The information obtained from small scale construction industries proved that they have poor knowledge about the aftermath of the waste generated. The percentage of recycling in the construction industry is low. Construction wastes that are often reused are concrete, wood and bricks. In Indian scenario, it becomes important to impart waste management tool for residential, industrial, commercial and infrastructure projects. The purpose of such tool is to estimate the quantity of waste that can be generated in the ongoing projects. The study of various construction industries proved that the importance given to waste management tool in India is very low.

The analysis from the study projected the waste percentage of 11.28%, which has been found for in the management plan. This means that proper management plans will have to be adopted such as adequate planning, controlling and supervision. Appropriate construction methods have to be followed. Waste Management Plans must be installed and monitored regularly. Adopting such strategies reduces the waste percentage for management by 6.66%. For workers' mistakes, waste contributed is computed to be 10.686%. To minimize these waste, the training for workers should be sufficient, the worker must be monitored frequently to minimize damages. The waste caused due to workers mistakes can be reduced by 5.64%.

The waste due to design contributes about 10.324%. The waste can be mitigated by adopting a proper design, improving design information and avoiding inexperienced designer. The mitigation strategies for design can be reduced by 5.67%. The waste from manufacturing contributes about 9.867%. To reduce such waste, it is important to manufacture the material with standard sizes, good quality and adequate product information. Manufacturing waste can be reduced by 5.85% if the mitigation strategies are followed.

The waste from poor site conditions contributed 9.39%. The waste generated from site conditions can be minimized by improving lighting facilities, avoiding congestion of materials. These strategies reduce the waste by about 5.41%. The waste generated from material handling contributes 9.25% of total waste contributed. To diminish such waste, the material should be stored in a suitable place, damage during transporting must be reduced and the tools which are not suitable should be avoided. Material handling waste can be reduced by 5.30%.

Procurement errors contributed 9.062% of total waste. To minimize the waste contributed, ordering errors, errors in shipping, mistakes in quantity surveying should be avoided. Adopting the strategies the waste reduces by 5.11%. Improper logistics contributed 8.72%. These wastes are reduced by following appropriate delivery method and appropriate delivery schedule. The mitigation strategies for logistics can reduce the waste by 4.72%.

The waste from operation error contributed 7.673%. The strategy adopted to reduce such waste is by reducing error caused due to worker specialised in a particular work. Operation waste can be reduced by about 4.43%. The external sources contribute about 7.026% of waste. The waste can be reduced by restricting workers from theft, adopting safety measures to prevent accidents and taking precautionary measures during natural disasters. Adopting the mitigation strategies for external sources reduces the waste by 4.21%.

Based on the contribution rates of different sources of construction waste, the mitigation strategy is adopted and applied to minimize the waste to a maximum extent.

6.0 CONCLUSION

It is observed from the analysis that among the various sources of construction waste management plan contributes higher rate than other sources. The contribution rate for worker's mistake and design are equal and holds place next to management plan. The other sources of waste generation, such as waste from manufacturing, poor site conditions, material handling and procurement errors contributed slightly less rate than design and worker's mistake. Based on the contribution rates, mitigation strategies were recommended to minimize the construction waste. The mitigation strategies such as adequate planning, controlling and supervision, following appropriate construction methods, monitoring waste management plans is the key to reduce waste to a maximum extent. The other mitigation measures such as giving sufficient training for workers, monitoring the workers frequently, adopting the proper design, improving design information, avoiding inexperienced designer further reduces the construction waste. The total construction waste that can be reduced by adopting an appropriate mitigation strategy for each source is 53%.

ACKNOWLEDGEMENT

The authors are grateful to ME Construction Management and Department of Civil Engineering of Coimbatore Institute of Technology, Coimbatore, India for the technical support provided for this research work.

REFERENCES

A. Gliem, Rosemary & R. Gliem, (2002). Calculating, Interpreting and Reporting Cronbach's Alpha Reliability Co-efficient for Likert-Type Scales, 82-88.

Babatunde & Solomon Olusola, (2012). Quantitative Assessment of Construction Materials Wastage in the Nigerian Construction Sites. *Journal of Emerging Trends in Economics and Management Sciences,* 3:238-241.

B. A. G. Bossink & H. J. H. Brouwers, (1996). Construction waste quantification and source evaluation. *Journal of Construction Engineering and Management,* 122(1):55–60.

Burcu Salgın.,Atacan Akgün., Nilay Coşgun.&, Kofi Agyekum (2017). Construction Waste Reduction through BIM-Based Site Management Approach. *International Journal of Engineering Technologies*, 3(3):135-142.

Carlos T. Formoso, LucioSoibdman, Claudia De Cesare & Edurado L.Isatto, (2002). Material Waste in Building Industry: Main Causes and Prevention. *Journal of Engineering and Management,* 128(4):316-325.

Job Thomas & Wilson P.M, (2013). Construction Waste Management in India. *American Journal of Engineering Research*, 2:06-09.

Mansi Jain, (2012). Economic Aspects of Construction Waste Materials in terms of cost savings – A case of Indian Construction Industry. *International Journal of Scientific and Research Publication,* 2:01-07.

M.Tavakol & R. Dennick, (2011). Making Sense of Cronbach's Alpha. *International Journal of Medical Education,* 2:53-55.

Nikola Karanovic & Aleksander Djuric, (2012). Quantitative Analysis of Construction Waste in the city of Novi Sad, Serbia. *International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering,* 6:13-15.

O.O. Fadiya, P.Georgakis, and E. Chinyio ,(2014).Quantitative Analysis of the Sources of Construction Waste. *Journal of Construction Engineering*, vol.2014.

R.M.Gavilan & L. E Bernold (1994). Source Evaluation of Solid Waste in Building Construction. *Journal of Construction Engineering and Management,* 120:536-552.

R.Navon & O. Berkovich, (2006). An automated model for materials management and control. *Construction Management and Economics*, 24(6): 635–646.

Sasitharan Nagapan, Ismail Abdul Rahman & Ade Usmi, (2012). Factors Contributing to Physical and Non Physical Waste Generation in Construction Industry. *International Journal of Advances in Applied Science,* 1(1):01-10.

T.O.Adewuyi & I.A.Odesola, (2015). Factors Affecting Material Waste on Construction Sites in Nigeria. *Journal of Engineering and Technology*, 6:82-99.